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A FUNCTIONAL ANALYSIS OF HAIR PULLING

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We experimentally assessed the functions of hair pulling and hair manipulation of a 19-year-old woman (Kris) with moderate mental retardation and cerebral palsy. In Phase 1 a functional analysis revealed that Kris pulled and manipulated hair for the greatest amount of time in the alone condition, suggesting that the behaviors were maintained by some form of automatic reinforcement (Vaughan & Michael, 1982). In Phase 2 we assessed the nature of the sensory stimulation that maintained hair pulling by providing continuous access to previously pulled or cut hair and, thereafter, by having Kris wear a rubber glove. The results suggested that hair pulling was maintained by digital-tactile stimulation (automatic positive reinforcement). These findings are discussed, and recommendations for further analyses of automatically reinforced habit behaviors are provided.

DESCRIPTORS: hair pulling, functional analysis, trichotillomania, sensory reinforcement

Noticeable hair loss produced by the pulling of one's own hair, often associated with reported experiences of "gratification, pleasure, or sense of relief," is an identifying characteristic of trichotillomania (American Psychiatric Association, 1994). A majority of studies report that hair pulling typically occurs when the individual is alone, and that the behavior produces a reduction in "tension" or a change in relative "emotional" states such as boredom or anxiety (e.g., Christenson, Mackenzie, & Mitchell, 1991; Stanley, Borden, Mouton, & Breckenridge, 1995). Indeed, the trichotillomania literature relies primarily upon reported emotional states in an attempt to explain the variables that control hair pulling (e.g., Stanley et al., 1995). An obvious problem with this type of assessment is that internal states are by definition unobservable, and therefore are difficult to measure and verify.

It appears that the current conceptualization of trichotillomania, or chronic hair pulling, is unduly complex and has little or no empirical support for the putative variables that maintain this behavior. In order to further our scientific understanding of this behavior, it is necessary to develop a methodology to systematically analyze variables that are manipulable and that produce observable changes in behavior. Such a methodology should strive to explain the variables that maintain a behavior in the most parsimonious terms possible.

Behavioral conceptualizations have suggested that, if a behavior occurs in the absence of other individuals, it is assumed to be maintained by automatic reinforcement (Vaughan & Michael, 1982; Vollmer, 1994) or, more specifically, by sensory-perceptual reinforcement (e.g., Lovaas, Newsom, & Hickman, 1987; Rincover, 1978). In light of this assumption, habit behaviors such as hair pulling and fingernail biting are thought to be automatically reinforced. Miltenberger, Fuqua, and Woods (1998) have emphasized the need for the specific identification of the function of these habit behaviors. Even though habit behaviors may occur primarily

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when the individual is alone, engagement in many of these behaviors can result in an observable response product (e.g., bald areas, extremely short fingernails). Thus, it is feasible that the product of the behavior, rather than the behavior per se, could be maintained by social reinforcement (e.g., attention). Interestingly, Grace, Thompson, and Fisher (1996) found that tissue damage that was produced by an individual's covert self-injurious behavior was influenced by socially mediated consequences even though such consequences were not immediately contingent upon the target behavior. Hence, functional analysis of habit behavior is valuable not only from the standpoint of extending our understanding of behavior but also for proper classification of behavior.

Researchers have conducted extended functional analyses of self-injurious behavior (SIB), exhibited by individuals with varying levels of mental retardation, that persisted in the absence of socially mediated reinforcement. In a series of experiments, Kennedy and Souza (1995) first determined that the eye poking of a 19-year-old man with mental retardation was maintained in the absence of social interaction. To test their hypothesis that contact of the individual's finger to his eye produced reinforcing stimulation, an antecedent condition was used in which the individual wore transparent goggles. Although a typical pattern of extinction responding was not observed, the results of the analysis supported the position that the product of finger-to-eye contact maintained this behavior.

In a similar analysis, Piazza, Hanley, and Fisher (1996) used a series of experiments to determine the function of cigarette pica exhibited by a 17-year-old man with mental retardation. The researchers first demonstrated that the behavior occurred during conditions in which cigarettes containing tobacco (nicotine) were available, but did not occur during conditions in which only herbal cigarettes (no nicotine) were present. Using a choice assessment, Piazza et al. further determined that the tobacco per se was the preferred aspect of the cigarette (vs. the paper or filter). In addition, the authors demonstrated (via traditional functional analysis) that cigarette pica was maintained independent of social consequences.

Acquiring knowledge of the function of hair pulling via functional analysis (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994) is important from the standpoint of scientific advancement in the analysis of human behavior; however, such assessment has not typically been applied to habit behaviors. In the absence of a functional analysis, a number of studies have described what the hair puller does with pulled hairs (Barmann & Vitali, 1982; Barrett & Shapiro, 1980; Maguire, Piersel, & Hauser, 1995), but none has provided a formal response definition or measurement of the postpulling behavior. If hair pulling occurs primarily when the individual is alone, it is possible that the postpulling behavior is the primary consequence that maintains hair pulling. In the only study that applied a functional analysis to hair pulling and measured postpulling behavior (hair manipulation), Miltenberger, Long, Rapp, Lumley, and Elliott (1998) found (as with hair pulling) that hair manipulation occurred almost exclusively while a 38-year-old woman with mental retardation was alone. The manipulation of hair occurred only after the hair was pulled from the individual's scalp or wig. This led Miltenberger et al. to speculate that hair pulling was maintained by automatic positive reinforcement. Unfortunately, the precise sensory mechanisms (e.g., Rincover, Cook, Peoples, & Packard, 1979) responsible for maintaining hair pulling for this individual were not experimentally assessed in this investigation.

In the present investigation, we utilized a functional analysis (Iwata et al., 1982/1994)

to evaluate the hair pulling of a young adult with moderate mental retardation. A series of analyses was conducted to rule out socially mediated forms of reinforcement (via traditional functional analysis), to elucidate the nature of the automatic reinforcement (positive or negative), and to identify and isolate the sensory stimulation that maintained hair pulling.

PHASE 1: FUNCTIONAL ANALYSIS OF HAIR PULLING

Method

Participant and Setting

Kris was a 19-year-old woman with severe mental retardation and mild cerebral palsy. She was able to ambulate, follow simple instructions, and communicate with single words. Due to a childhood stroke, Kris walked with a limp and could not open her left hand. Consequently, she pulled and manipulated her scalp hair with only her right hand. Her mother reported that Kris had pulled scalp hair since approximately age 3 and that the behavior would occasionally remit for periods up to a month. In the past, Kris' hair pulling was unsuccessfully treated with Trazodone and parental scolding. According to her mother, Kris usually pulled scalp hair while watching television and in bed. After pulling a hair, she rolled it between her thumb and index finger, rubbed the hair on her lips, and then chewed on the hair while pulling it with her fingers. Her mother reported that periods of increased baldness seemed to be correlated with constipation, which may indicate that Kris was ingesting hairs. Kris did not appear to ingest hair during either phase of this investigation. Hair pulling produced an obvious area of baldness 5 cm in diameter on the top of her scalp.

All sessions in this phase, except for those in the demand condition, were conducted in the same university research room (2.5 m by 3.5 m, furnished with a recliner, a chair, and a television on a cart) with a one-way observation window. The demand condition was conducted in a separate room (3 m by 4 m) that contained a chair and a table with four piles of multicolored papers and one pile of envelopes.

Target Behaviors and Interobserver Agreement

The target behaviors for Kris were hair pulling and hair manipulation. *Hair pulling* was defined as any contact of the fingers of her right hand with her scalp. *Hair manipulation* was defined as rolling of pulled hair between any fingers, gazing at pulled hair, and any contact of hair with the lips or mouth. Hair manipulation onset always occurred within 3 s of hair pulling offset. Data were collected in 5-min segments by videotaping Kris through the one-way mirror. Using a real-time recording method (Miltenberger et al., 1998) each 5-min segment was divided into 300 s (on a scoring sheet) and scored on a second-by-second basis for the occurrence and nonoccurrence of the target behaviors to arrive at a percentage of time measure. This scoring method allows observers to identify the onset and offset of the target behaviors with precision because the observer is able to slow the tape speed substantially (as well as pause and reverse the segment), thereby obtaining an accurate observation of the target behaviors. Interobserver agreement was assessed by having a second observer independently score 30% of the sessions and then comparing the scoring sheet of the second rater to the first for the occurrences and nonoccurrences of hair pulling and hair manipulation. The number of agreements on the occurrence and nonoccurrence of each behavior was divided by the total number of seconds in the session and multiplied by 100% to arrive at the percentage agreement between raters. The mean

interobserver agreement scores for hair pulling and hair manipulation were 100%.

Experimental Design

Kris was exposed to four alternating functional analysis conditions (Iwata et al., 1982/1994) in a multielement design across 3 days. Due to the high level of hair pulling that occurred during informal observations, the length of the session was limited to 5 min (Miltenberger et al., 1998). Five to six sessions were conducted daily, and each was separated by approximately 5 min. Conditions were presented at least three times over the course of the analysis, and a specific therapist was used for each condition to enhance discrimination of the consequences among conditions.

Demand. During this condition, a therapist stood behind Kris, who was seated at a large table. The therapist presented a task (from her prevocational curriculum) that involved taking single pieces of different-colored paper off four piles in a sequential order and placing the collated papers into a specified envelope. Kris was shown the correct sequence for the papers and then prompted every 20 to 30 s in a three-step sequence (verbal prompt; verbal prompt and pointing; verbal prompt, pointing, plus manual guidance) to stack the papers accordingly. Praise was provided for 2 to 3 s contingent upon completing the correct paper sequence and filling the envelope. If hair pulling occurred, the therapist removed the materials and suspended all interactions with Kris for 30 s. This condition was designed to evaluate socially mediated negative reinforcement.

Attention. Kris and a therapist were seated side by side in the room. Kris was given a video to watch on the television while the therapist shuffled papers and wrote in a notebook. No interaction took place between them unless Kris pulled hair. Contingent on hair pulling, the therapist reached over and gently pressed Kris' arm down from her head and provided disapproving statements (e.g., "Don't pull out your hair"). The purpose of this condition was to evaluate to the role of social-positive reinforcement in the maintenance of Kris' hair pulling.

Alone. Kris was seated alone in the observation room to watch a video on the television. This condition was used to evaluate her hair pulling in the absence of socially mediated consequences.

Control. Kris was seated across from a therapist in the research room and was given continuous access to toys that her mother identified as being preferred. Therapist praise and pats to Kris' arm were provided at least once every 10 s, and there was no social consequence for hair pulling. This condition served as a control comparison for the other conditions.

Results and Discussion

Data in Figure 1 indicate that Kris pulled ($M = 7.2\%$) and manipulated ($M = 34.5\%$) scalp hair for the highest percentage of time in the alone condition. A lower level of hair pulling ($M = 0.75\%$) and hair manipulation ($M = 0.5\%$) occurred during the control condition. Kris also pulled hair during the attention condition ($M = 0.97\%$), but only after she exhibited a burst of other disruptive behaviors (e.g., slamming the back of a recliner into the wall while staring at the therapist). Kris did not pull or manipulate hair during the demand condition.

This pattern of data suggests a default interpretation; that is, the behaviors were maintained by a form of automatic reinforcement (Vaughan & Michael, 1982; Vollmer, 1994). We speculated that the manipulation of hair by Kris during the alone condition, which occurred almost five times more often than hair pulling, served to maintain hair pulling. Phase 2 of this investigation was designed to isolate the sensory consequences that maintained hair pulling and manipulation.

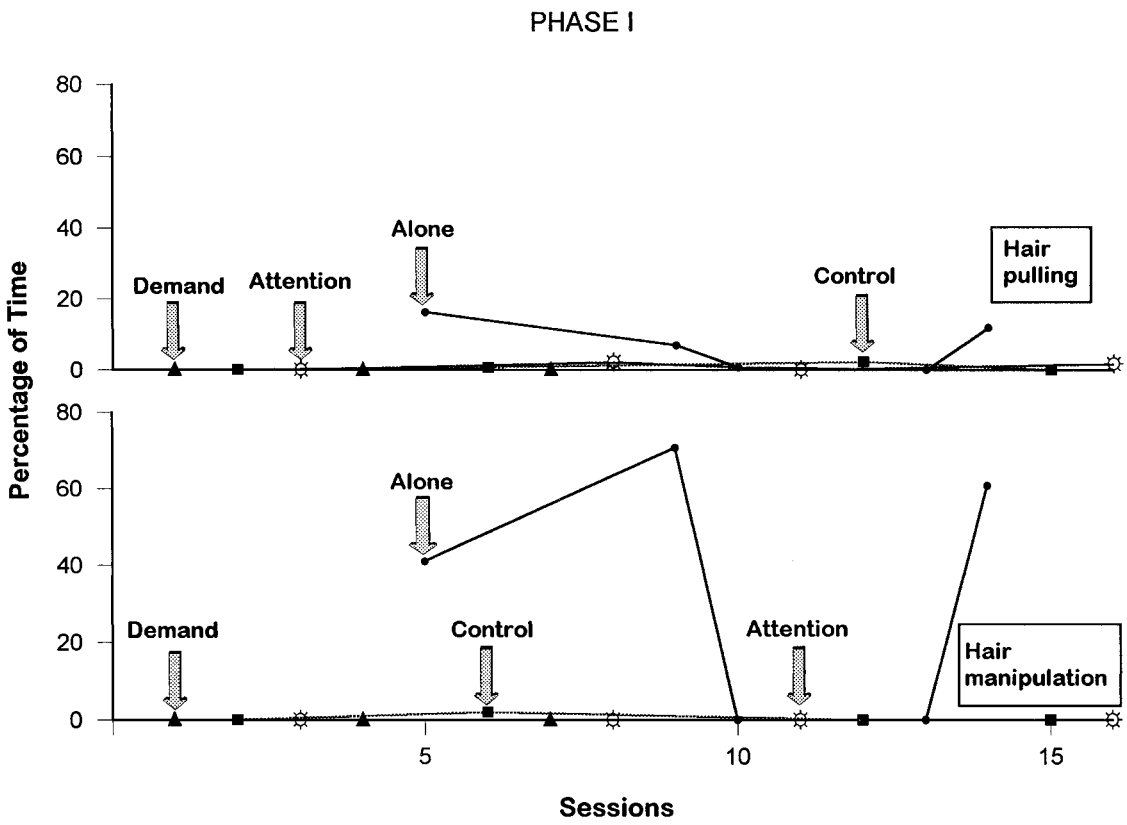

Figure 1. The percentage of time Kris engaged in hair pulling (top panel) and hair manipulation (bottom panel) across alone, attention, control, and demand conditions. Social consequences were provided for hair pulling only.

PHASE 2: ISOLATING SENSORY VARIABLES INVOLVED IN MAINTAINING HAIR PULLING

In Phase 2, we conducted experimental manipulations to determine the stimulus conditions that maintained Kris' hair pulling. We speculated that hair pulling was maintained by hair manipulation, which produced sensory-perceptual reinforcement. In light of the fact that Kris rolled hairs between her fingers for a considerable duration after pulling (approximately 70% of the total hair manipulation duration), we postulated that her hair pulling was maintained primarily by digital-tactile stimulation. Thus, we hypothesized that if previously cut or pulled hairs ("free hairs") were available to manipulate with her fingers, she would not pull her own scalp hair. Furthermore, we speculated that if hair manipulation was maintained by digital-tactile reinforcement, attenuation of that sensation should produce extinction (e.g., Rincover, 1978; Rincover et al., 1979) of hair manipulation, and hair pulling would then abate.

Method

Setting

All sessions in this phase were conducted in the same room and manner as in Phase 1.

Response Measurement and Interobserver Agreement

Response definitions, data collection, scoring, and reliability procedures remained

the same as in the first phase. Thirty-three percent of the sessions conducted in this phase were scored by a second rater. Mean interobserver agreements for hair pulling and hair manipulation were 99.9% (range, 99.7% to 100%) and 99.3% (range, 98.7% to 100%), respectively.

Experimental Design

Kris was exposed to three experimental conditions across 2 days in a multielement design. At least four 5-min sessions were conducted for each condition.

Alone. This condition was conducted in the same manner as in Phase 1 and was used as a comparison for the other conditions.

Free hair. Kris was seated in the room to watch a video in the same manner as in the alone condition but also wore a white T-shirt over her clothes and was given 20 to 25 hairs (collected from Kris' bed and after a haircut). A therapist spread hairs on the front of the T-shirt, placed additional hairs on a table next to Kris (to minimize response effort), then pointed to the hairs and told Kris "you can have these" and left the room. This condition was used to determine if hair manipulation occurred independent of hair pulling when free hairs were present.

Glove. This condition was identical to the free hair condition except that Kris' right hand was fitted with a tight latex glove. Prior to the first session in this condition, she wore the glove for 10 min while in the presence of a therapist. This condition was used to assess occurrences of hair pulling and hair manipulation when digital-tactile stimulation was altered.

Results and Discussion

Figure 2 shows that the percentage of time Kris engaged in hair pulling and hair manipulation varied depending upon the condition. Similar to Phase 1 (M = 7.18%), hair pulling in this phase was found to be highest during the alone condition (M = 6.86%). Almost no hair pulling occurred during the free hair condition (M = .20%), and none occurred during the glove condition. In contrast, hair manipulation was exhibited for the greatest duration in the free hair condition (M = 66.3%), followed by the alone condition (M = 51%), but almost no hair manipulation occurred in the glove condition (M = 0.33%).

The results strongly suggest that Kris' hair pulling was maintained by sensory stimulation related to the digital-tactile manipulation of pulled hairs. This position is supported by the high level of hair manipulation during the free hair and alone conditions, and the near-zero and zero levels of hair pulling observed in the free hair and glove conditions, respectively. In addition, during the first two sessions in which Kris wore the glove, she immediately picked up a free hair, briefly rolled it between her fingers, dropped it, and thereafter did not manipulate hair. She did not exhibit any novel behavior (e.g., staring at the glove) that would suggest the glove distracted her during these sessions.

GENERAL DISCUSSION

The results of Phase 1 indicated that hair pulling and hair manipulation were not maintained by socially mediated reinforcement and were consistent with previous findings (Miltenberger et al., 1998). The fact that instances of hair pulling were followed by extended periods of hair manipulation suggested that both behaviors were maintained by sensory-perceptual reinforcement (Lovaas et al., 1987). In Phase 2, the use of free hair demonstrated that hair manipulation occurred independent of hair pulling. Similarly, the high level of hair manipulation exhibited when provided free hairs and the near absence of hair pulling and hair manipulation while she wore a glove supported a sensory stimulation hy-

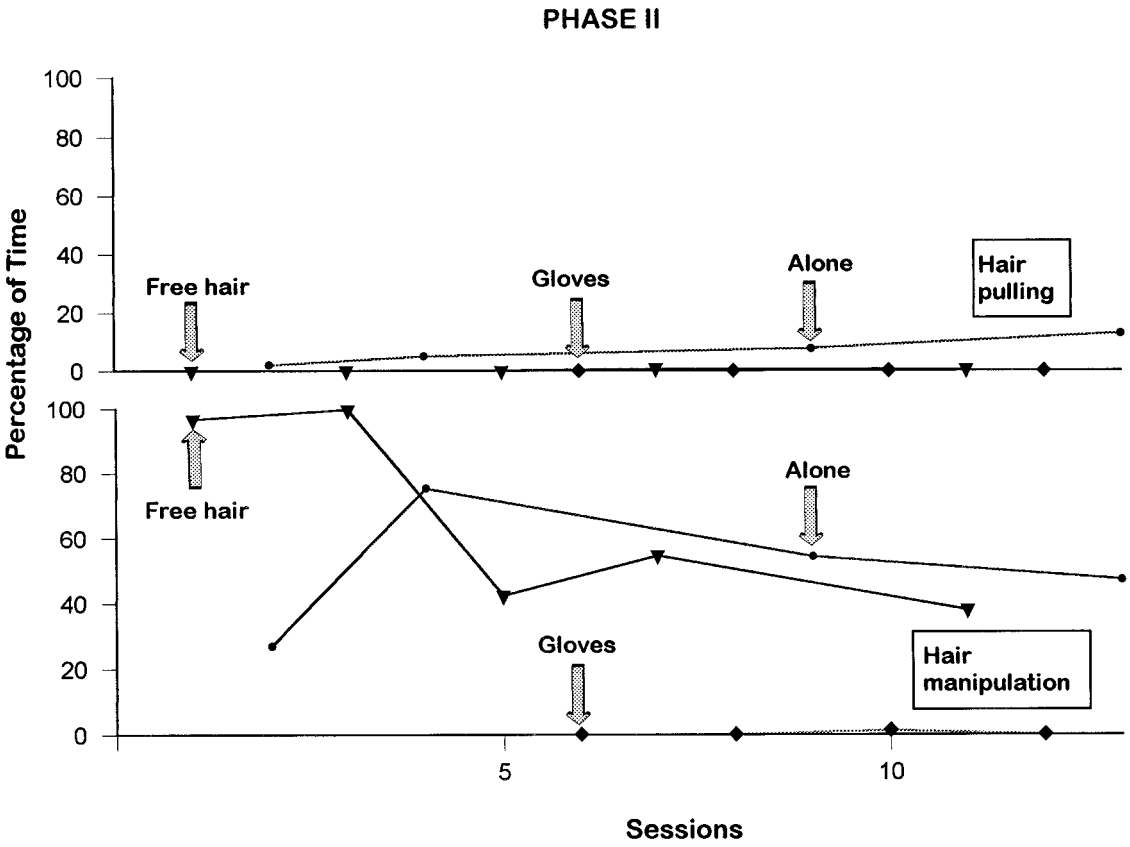

Figure 2. The percentage of time Kris engaged in hair pulling (top panel) and hair manipulation (bottom panel) across alone, free hair, and glove conditions.

pothesis (automatic positive reinforcement). Thus, appeals to emotional states such as tension reduction were not necessary.

The results from this investigation extend the current literature on the assessment of hair pulling in a number of ways. First, hair pulling and hair manipulation were experimentally shown to occur in the absence of socially mediated consequences. Although this finding seems only to confirm numerous indirect reports (e.g., Christenson, Pyle, & Mitchell, 1991; Stanley et al., 1995), the functional analysis results replicate those of Miltenberger et al. (1998) and represent only the second study to apply such methods to hair pulling. Second, the use of free hair enabled us to offer a more parsimonious alternative to the tension-reduction hypothesis, as well as to demonstrate that hair pulling occurred primarily to provide hair for this individual to manipulate. Third, the use of a rubber glove (that altered digital-tactile stimulation) to identify a mechanism involved in sensory reinforcement (e.g., Rincover et al., 1979) represents another unique approach to the assessment of hair pulling.

A limitation to this study is that the sensory-perceptual mechanisms that maintained hair manipulation may not have been exhaustively identified. The topography of hair manipulation suggests that other mechanisms such as oral-tactile stimulation and arm-movement proprioception (Lovaas et al., 1987; Rincover et al., 1979) may have also provided sensory reinforcement. However, digit-to-hair contact was first in a chain

of responses and accounted for the greatest proportion of hair manipulation duration.

In the present investigation, a methodology to assess hair pulling with covarying hair manipulation provided at least two directions for future research on hair pulling assessment. First, Kris exhibited a nearly identical pattern in both the alone and free hair conditions, in which she typically manipulated hair for 30 to 60 s, discarded the hair, and then immediately acquired another hair and repeated the process. Such patterns could possibly provide additional information about the sensory mechanisms involved and guide researchers to conduct further analyses. This pattern raises questions as to what aspect of the hair or the behavioral product changed during the course of hair manipulation. Did the hair become too wet to produce any further tactile stimulation? Could hair manipulation have caused her arm to become tired, thus making its change of position more probable? Such temporal patterns, when experimentally analyzed (e.g., comparing hair manipulation levels with dry vs. wet hairs), may help to elucidate the mechanisms that maintain automatically reinforced behaviors. This study also presents an interesting argument for the reclassification of behaviors that occur in the absence of socially mediated reinforcement. Presently, the classification of behaviors such as hair pulling and fingernail biting is based on topography rather than operant function. Hansen, Tishelman, Hawkins, and Doepke (1990) define nervous habits as behaviors that serve a self-stimulatory or a tension-reduction function. However, this behavioral classification overlaps with the functional definition of stereotypic or self-stimulatory behaviors (e.g., Lovaas et al., 1987). As researchers isolate specific functions for other automatically reinforced habit behaviors, it may become useful to classify such behavior according to the determined function. Finally, research is necessary to determine the extent to which the basic literature on schedule-induced behavior (Falk, 1994; Foster, 1978; Overskeid, 1992) and the passage of time (Haight & Killeen, 1991) are relevant to patterns of habit behaviors exhibited by humans.

REFERENCES

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.

Barmann, B. C., & Vitali, D. L. (1982). Facial screening to eliminate trichotillomania in developmentally disabled persons. *Behavior Therapy, 13,* 735–742.

Barrett, R. P., & Shapiro, E. S. (1980). Treatment of stereotyped hair-pulling with overcorrection: A case study with long term follow-up. *Journal of Behavior Therapy and Experimental Psychiatry, 11,* 317–320.

Christenson, G. A., Mackenzie, T. B., & Mitchell, J. E. (1991). Characteristics of 60 adult chronic hair pullers. *American Journal of Psychiatry, 148,* 365–370.

Christenson, G., Pyle, R., & Mitchell, J. (1991). Estimated lifetime prevalence of trichotillomania in college students. *Journal of Clinical Psychiatry, 52,* 415–417.

Falk, J. L. (1994). Schedule-induced behavior occurs in humans: A reply to Overskeid. *Psychological Record, 44,* 45–62.

Foster, W. S. (1978). Adjunctive behavior: An underreported phenomenon in applied behavior analysis? *Journal of Applied Behavior Analysis, 4,* 545–546.

Grace, N. C., Thompson, R., & Fisher, W. W. (1996). The treatment of covert self-injury through contingencies on response products. *Journal of Applied Behavior Analysis, 29,* 239–242.

Haight, P. A., & Killeen, P. R. (1991). Adjunctive behavior in multiple schedules of reinforcement. *Animal Learning & Behavior, 19,* 257–263.

Hansen, D. J., Tishelman, A. C., Hawkins, R. P., & Doepke, K. J. (1990). Habits with potential as disorders: Prevalence, severity, and other characteristics among college students. *Behavior Modification, 14,* 66–80.

Iwata, B. A., Dorsey, M. F., Slifer, K. J., Bauman, K. E., & Richman, G. S. (1994). Toward a functional analysis of self-injury. *Journal of Applied Behavior Analysis, 27,* 197–209. (Reprinted from *Analysis and Intervention in Developmental Disabilities, 2,* 3–20, 1982)

Kennedy, C. H., & Souza, G. (1995). Functional analysis and treatment of eye poking. *Journal of Applied Behavior Analysis, 28,* 27–37.

Lovaas, I., Newsom, C., & Hickman, C. (1987). Self-stimulatory behavior and perceptual reinforcement. *Journal of Applied Behavior Analysis, 20,* 45–68.

Maguire, K. B., Piersel, W. C., & Hauser, B. G. (1995). The long-term treatment of trichotillomania: A case study of a woman with profound mental retardation living in an applied setting. *Journal of Developmental and Physical Disabilities, 7,* 185–202.

Miltenberger, R. G., Fuqua, R. W., & Woods, D. W. (1998). Applying behavior analysis with clinical problems: Review and analysis of habit reversal. *Journal of Applied Behavior Analysis, 31,* 447–469.

Miltenberger, R. G., Long, E. S., Rapp, J. T., Lumley, V. A., & Elliott, A. J. (1998). Evaluating the function of hair pulling: A preliminary investigation. *Behavior Therapy, 29,* 211–219.

Overskeid, G. (1992). Is any human behavior schedule-induced? *Psychological Record, 42,* 323–340.

Piazza, C. C., Hanley, G. P., & Fisher, W. W. (1996). Functional analysis and treatment of cigarette pica. *Journal of Applied Behavior Analysis, 29,* 437–450.

Rincover, A. (1978). Sensory extinction: A procedure for eliminating self-stimulatory behavior in psychotic children. *Journal of Abnormal Child Psychology, 6,* 235–246.

Rincover, A., Cook, R., Peoples, A., & Packard, D. (1979). Sensory extinction and sensory reinforcement principles for programming multiple adaptive behavior change. *Journal of Applied Behavior Analysis, 12,* 221–233.

Stanley, M. A., Borden, J. W., Mouton, S. G., & Breckenridge, J. K. (1995). Nonclinical hair-pulling: Affective correlates and comparison with clinical samples. *Behavior Research and Therapy, 33,* 179–186.

Vaughan, M. E., & Michael, J. L. (1982). Automatic reinforcement: An important but ignored concept. *Behaviorism, 10,* 217–227.

Vollmer, T. R. (1994). The concept of automatic reinforcement: Implications for behavioral research in developmental disabilities. *Research in Developmental Disabilities, 15,* 187–207.

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STUDY QUESTIONS

1. What is the traditional conceptualization of the "causes" of trichotillomania and what is its limitation?

2. Behavior that occurs when an individual is alone is often assumed to be maintained by automatic reinforcement. How might such behavior also be susceptible to social reinforcement?

3. What contingencies were placed on hair pulling and hair manipulation during the various conditions of the functional analysis?

4. What were the results of the initial functional analysis, and what were the authors' conclusions about the variables that maintained hair pulling and manipulation?

5. Describe the three conditions whose effects were evaluated in Phase 2.

6. Summarize the results obtained in Phase 2. What behavioral processes (mechanisms) most likely accounted for these results?

7. What additional types of interventions are suggested by the results obtained in this study?

8. From a behavioral standpoint, how might one best define a "habit disorder" in the absence of data on factors that maintain such problems?

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